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Emission Reductions and Cost-Effectiveness of Oxygenated Gasoline

Carbon Monoxide Emissions

In most of the areas designated carbon monoxide (CO) non-attainment areas the dominant source of the problem is mobile sources. The 1989 National Air Quality and Emission Trends Report[1] indicates that mobile sources account for about two thirds of CO emissions, a figure that is only slightly down from its 1980 level of 70%. Stationary and area sources of CO tend to be fairly constant in an absolute sense, declining only slightly over the 1980-1989 period.

Basically there are two variables that account for most of the change in mobile source CO emissions, fleet turnover and vehicle miles travelled (VMT) trends. Fleet turnover has acted over the last decade to bring CO emissions down by replacing old technology, higher-emitting vehicles with new technology, lower emitting ones. Even as they age and accumulate mileage, the newer technology vehicles emit less CO than the older ones did at similar stages in vehicle life. VMT generally trends up for the nation as a whole as population increases and per-capita mileage climbs on the average. Fleet turnover has had more influence on CO emissions over the last decade than VMT, accounting for the downward trend. The Agency's mobile emissions model predicts, though, that as the fleet conversion to newer technology is completed, fleet turnover will become more neutral with regard to emissions, and increasing VMT may bring about emissions increases. Figure 1 shows a projection of CO emissions for a hypothetical mid-atlantic city.

Technology-Specific Effects of Fuel Oxygen Content on CO Emissions

Agency data on the impact of oxygen on CO emissions have been collected as part of the Agency's Emission Factors program. Analyses of those data have been reported in various technical reports[2] and incorporated into a modified version of the MOBILE4 emissions model. These analyses distinguish three technology groupings and separately estimate their impact on CO emissions. Those impacts are shown below for light-duty vehicles:

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[1] National Air Quality and Emission Trends Report, 1989, February, 1991, U.S. Environmental Protection Agency, EPA-450/4-91-003, p. 3-17.

[2] "Derivation of Technology Specific Effects of the Use of Oxygenated Fuel Blends on Motor Vehicle Exhaust Emissions", October, 1988, Technical Report No. EPA-AA-TSS-PA-88-1. "Guidance on Estimating Motor Vehicle Emission Reductions From the Use of Alternative Fuels and Fuel Blends", January 29, 1988, Technical Report No. EPA-AA-TSS-PA-87-4.

Technology-Specific Effects
on Emissions of a Fuel with 3.5%
Oxygen and Volatility Matched to Base Fuel[3]

Vehicle Group	Effect of Blend on Emissions HC	CO	NOx
No Catalyst	-5.2%	-22.9%	+3.6%
Oxidation Catalyst	-14.8%	-33.0%	+3.8%
Closed Loop	-4.8%	-20.2%	+7.7%

Since current data offer no basis to reject the proposition that CO response is linear with percent oxygen, interpolation provides the reductions by technology type associated with 2.7% oxygen: -17.7% for pre-catalyst, -25.5% for oxidation catalyst, and -15.6% for 3-way catalyst/closed loop technology.

It is also assumed, based on analysis of the data from the Emission Factor program, that this oxygen impact remains relatively constant (on a percentage basis) as the vehicle accumulates mileage (and years of age). The impacts on light-duty vehicles for different technology categories by mileage are indicated in Figures 2 - 4.

Adaptive Learning Technology

There is a theoretical basis for expecting that the newer closed loop systems (approximately post-1984 LDVs) should show a smaller decrease in CO emissions with a given amount of oxygen in the fuel than is the case for earlier technologies. In EPA's Technical Report of Oct., 1988, referenced earlier, the available data on this technology were evaluated to see whether the theory could be supported. The conclusion finally drawn was that the theory could not be supported on the basis of the data examined, since the CO impact of 3.7% oxygen was even greater in the sample data than for other closed loop vehicles. The Agency is currently examining additional data on this question, but only minor changes are expected to the technology-specific reductions presented above.

Fleet Composition

During the period of time being modelled here, the composition of the light duty gasoline vehicle fleet is expected to complete a transition to 3-way/closed loop systems that is already well under way (by 1992 the older technologies are expected to comprise less than twenty percent of the fleet). This transition is presented graphically in Figure

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[3] Derived from Table 3-1 in "Guidance on Estimating Motor Vehicle Emission Reductions From the Use of Alternative Fuels and Fuel Blends", January 29, 1988, EPA Technical Report No. EPA-AA-TSS-PA-87-4, p. 35.

5 and in tabular form in Table 1. Other vehicle classes, such as heavy duty gas trucks, are not considered in Figure 5 or Table 1, but are taken into account in the later modelling of the overall impact of oxygen on CO. These fleet composition figures actually understate somewhat the completeness of the transition, since older vehicles tend to drive fewer annual miles than newer ones. This VMT differential is built into the mobile emissions model that is used in subsequent parts of this analysis and thus is taken into account in projecting fleet emissions. It should be noted here that fleet turnover rates vary somewhat by region of the country with a higher proportion of older vehicles being retained in the southwestern U.S.

Effect of Oxygen on Fleet CO Emissions Through Time

As discussed before, stationary and area sources of CO emissions tend to remain constant over time as indicated by the national inventory depicted in Figure 6[4]. Mobile source emissions of CO have been coming down for a number of years under the influence of fleet replacement and the introduction of vehicle inspection and maintenance (I/M) programs. That trend is expected to continue until about 1999 when the light duty fleet will be comprised almost entirely of 3-way/closed loop vehicles. The increase in VMT, previously masked in its effect by fleet turnover, will then bring about some increase in emissions.

The overall picture is presented in Figure 7 for a loosely modelled mid-Atlantic scenario whose mobile source emissions of CO in 1992 represented about 75% of total CO and where the stationary and area source components are assumed to remain constant in an absolute sense over the period of time modelled.[5] The CO emission level at 2.7% oxygen is 13% lower than the base case in 1992. By 1995 the difference is 12%, and by 2000 it is 11%. A west coast scenario should appear very similar in program effect except that the local fleet is older on average and thus is perhaps more responsive to the oxygen level. Since the west coast scenario was modelled after San Diego, the extent of stationary source involvement is lower and the proportional reductions in overall CO emissions attributable to oxygen are higher (graphics for this case are included as Appendix A). Individual control areas will vary, of course, in the extent of mobile source involvement in the CO inventory, but only in the cases of Steubenville and Winnebago do stationary and area sources play a dominant role. Information on assumptions used in this modelling and some of the more detailed results may be found in Appendix B.

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[4] "National Air Quality and Emission Trends Report", loc. cit.

[5] While the mid-Atlantic and West Coast scenarios discussed in this analysis are based, respectively, on some data for Philadelphia and San Diego, this modelling work should not be regarded as a rigorous accounting of emissions inventories for either area. The extent of stationary source influence and various other items of information were taken from area-specific data, but national default information was used to predict VMT growth, and certain other features of the local situations were not modelled rigorously, since these analyses were intended only as illustrative.

Impact of Fuel Oxygen on Ambient CO Air Quality

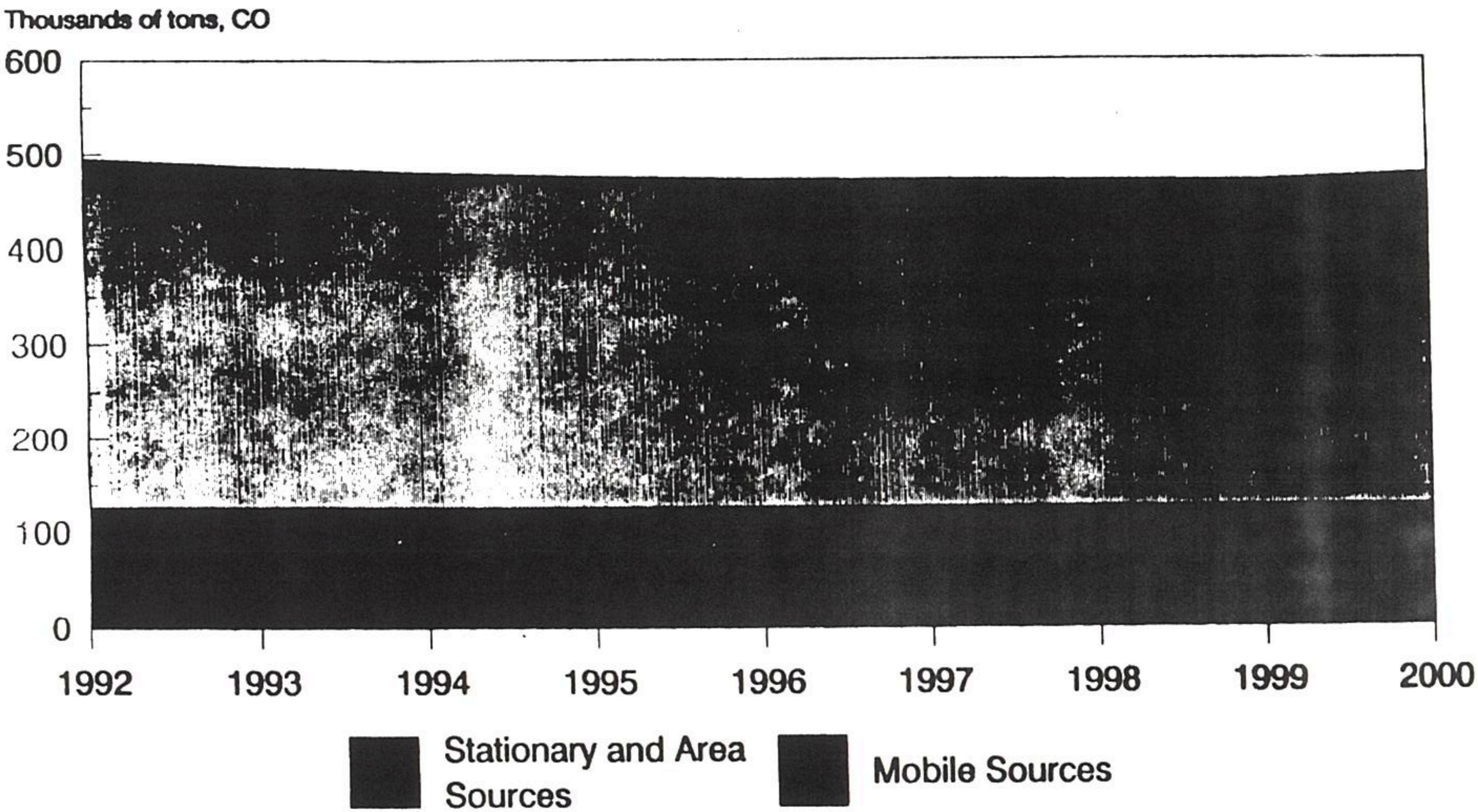
In order to model the impact of the proposed program on ambient CO levels, a "rollback" modelling approach has been used whereby a percentage decrease in emissions from all sources (including the relatively constant stationary and area sources) is applied to actual ambient levels projected forward to the time period being analyzed here. The actual data for Philadelphia's 1989 daily maximum overlapping 8-hour averages with correction for "double-counting" of high hourly readings are shown in Figure 8. Figure 9 shows the same data adjusted for the changes in emission levels expected between 1989 and 1992. The overall height of each bar shows the level to be expected in 1992 without the oxygen program, while the lower segment (for the four months where there are two segments) shows the ambient level expected with 2.7% oxygen. Figures 10 and 11 examine the ambient air quality for 1995 and 2000. A west coast scenario has been developed in a similar fashion using air quality data from San Diego and is presented in Appendix A. These attempts to illustrate the possible air quality effects of the oxygenated fuel program should not be taken as reliable guides to future air quality in the specific areas mentioned, since the ambient data are subject to climatic fluctuations, changes in traffic patterns, and other variables that cannot be reliably predicted. Because they include the stationary source component of the overall CO emissions inventory, these calculations may underestimate somewhat the impact of oxygenated fuels, since stationary sources may not substantially influence pollutant concentrations in those areas where monitors are located.

Cost-Effectiveness of Oxygen as a CO Reduction Strategy

The EPA Fuel Consumption Model, in a draft version not yet fully reviewed, projects VMT and fuel economy by vehicle class and combines this information into total fuel consumption for the years being modelled. These figures are general estimates, of course, and may vary from area to area with differences in vehicle class mix and the average age of the local fleet. The fraction of this national fuel consumption figure associated with a particular city for the months of its control period (Philadelphia was modelled here somewhat roughly to represent a mid-Atlantic general case) was carried forward into calculations of cost-effectiveness. Costs of the program per gasoline gallon, as determined in a separate analysis by an EPA contractor for east and west coasts, were multiplied by total gallons to obtain total program costs. These overall program costs were divided by tons of reduction to obtain cost-effectiveness in dollars per ton.

Table 2 presents the cost-effectiveness calculations by year for a general mid-Atlantic scenario (using stationary source involvement and VMT for Philadelphia as being more or less representative). A west coast scenario using San Diego as a general model is shown in Table 3. The per-gallon costs used in these tables are long-run cost figures. It is likely that short-run costs in 1992 will be higher, and also likely that the cost numbers in the later years will fluctuate with shifts in oil and basic commodity prices. A constant long-run per-gallon price is used in these tables to facilitate examination of the impact on cost-effectiveness of fleet composition and VMT trends over time. Since each year's program costs and the consequent emission reductions occur together in time and vary in direct proportion to one-another, the cost-effectiveness numbers have not been discounted.

Figure 1
Projection of Carbon Monoxide Emissions Mid-Atlantic Scenario



Carbon Monoxide Emission Rates
of Light Duty Gasoline Vehicles

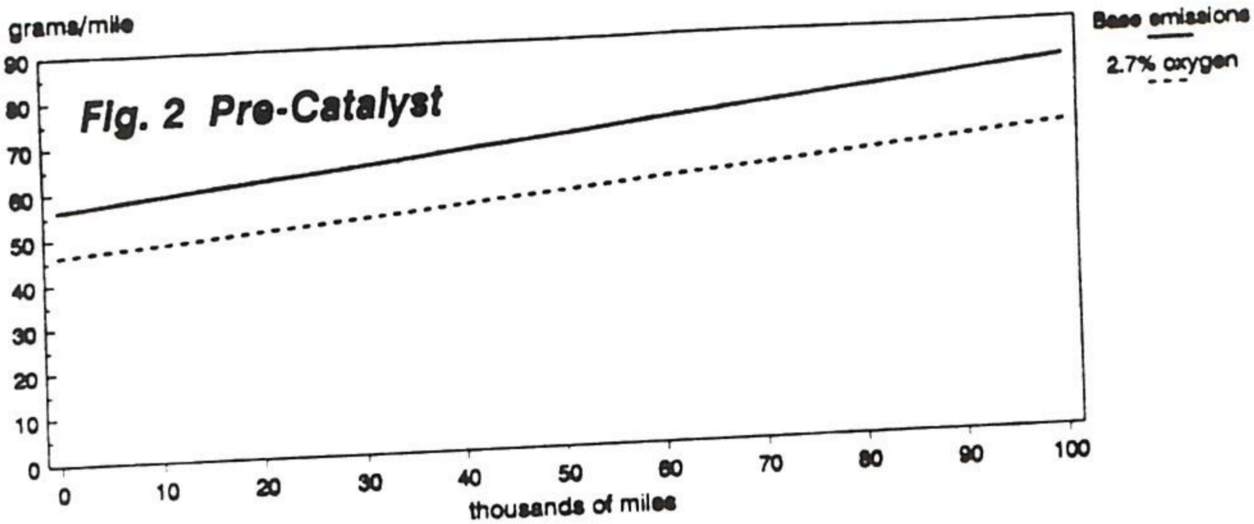


Fig. 2 Pre-Catalyst

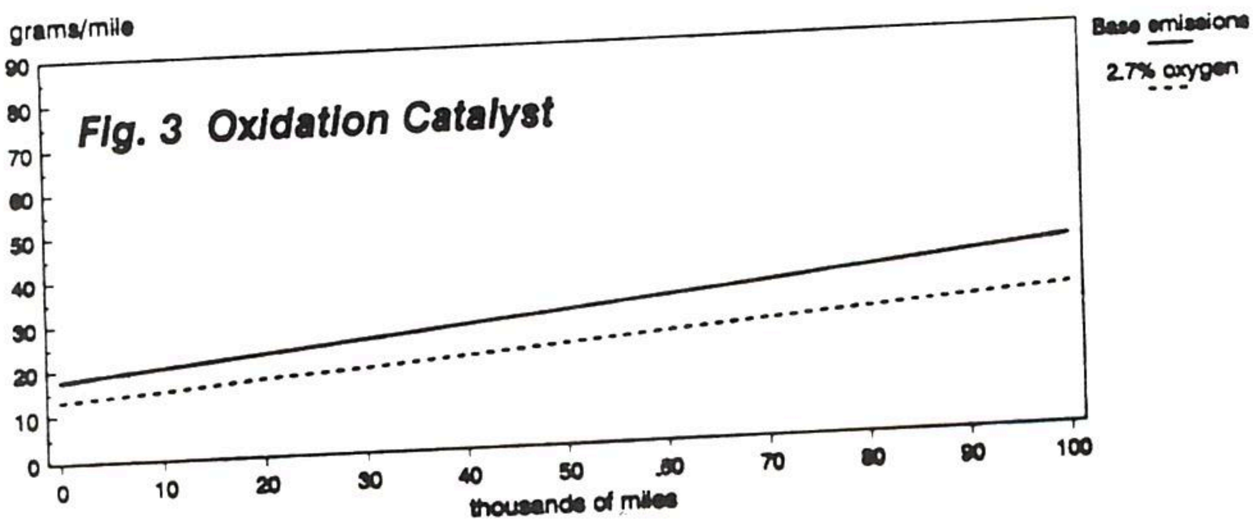


Fig. 3 Oxidation Catalyst

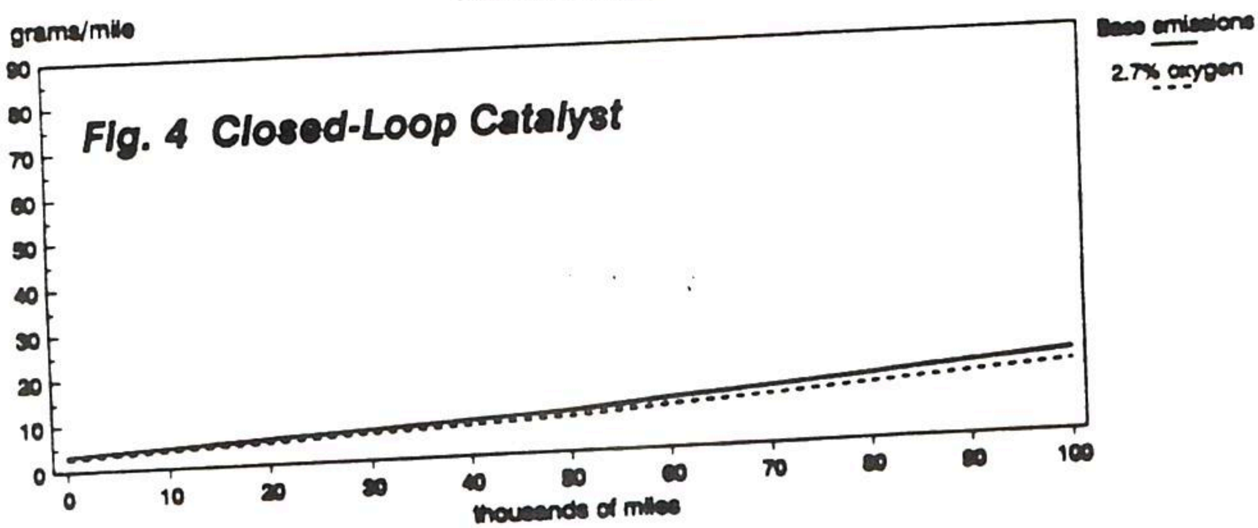


Fig. 4 Closed-Loop Catalyst

Figure 5

LDGV Fleet Composition

by Catalyst Technology Group

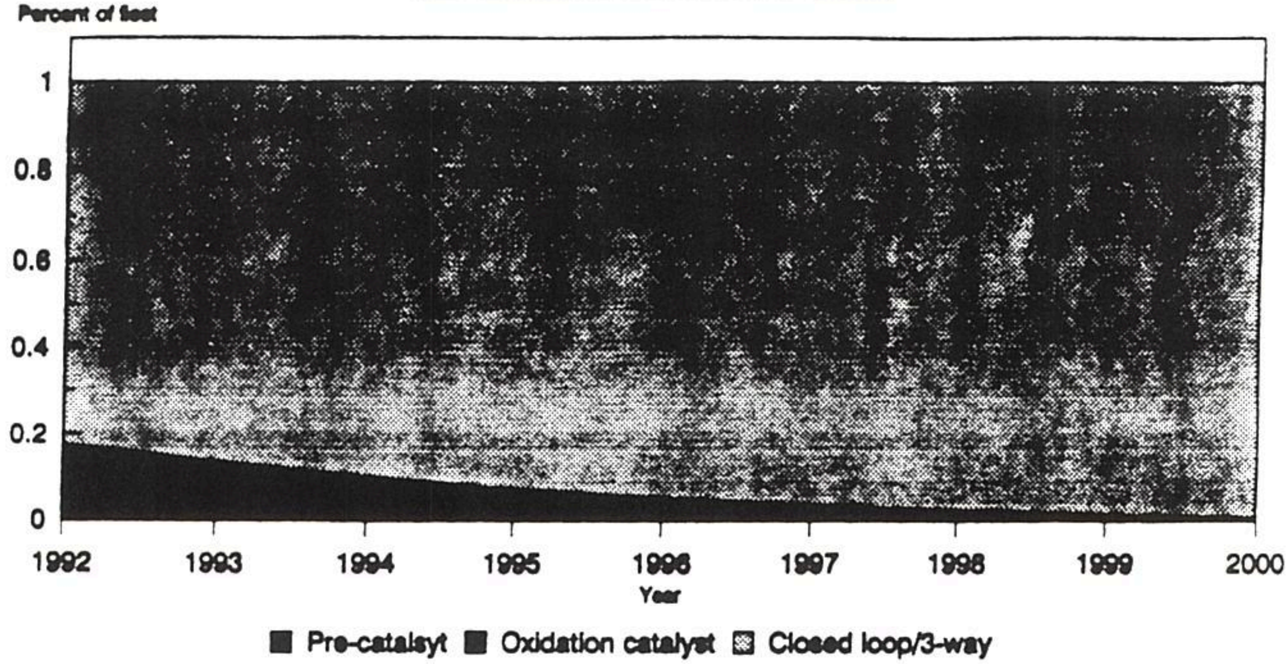


Table 1

Year	No Catalyst	Oxidation Catalyst	Closed Loop/3way
1992	0.022	0.152	0.826
1993	0.014	0.120	0.866
1994	0.008	0.092	0.900
1995	0.004	0.068	0.928
1996	0.001	0.049	0.950
1997	0.000	0.033	0.967
1998	0.000	0.022	0.978
1999	0.000	0.014	0.986
2000	0.000	0.008	0.992

Figure 6

National Trend in Emissions of Carbon Monoxide

_1980 - 1989_

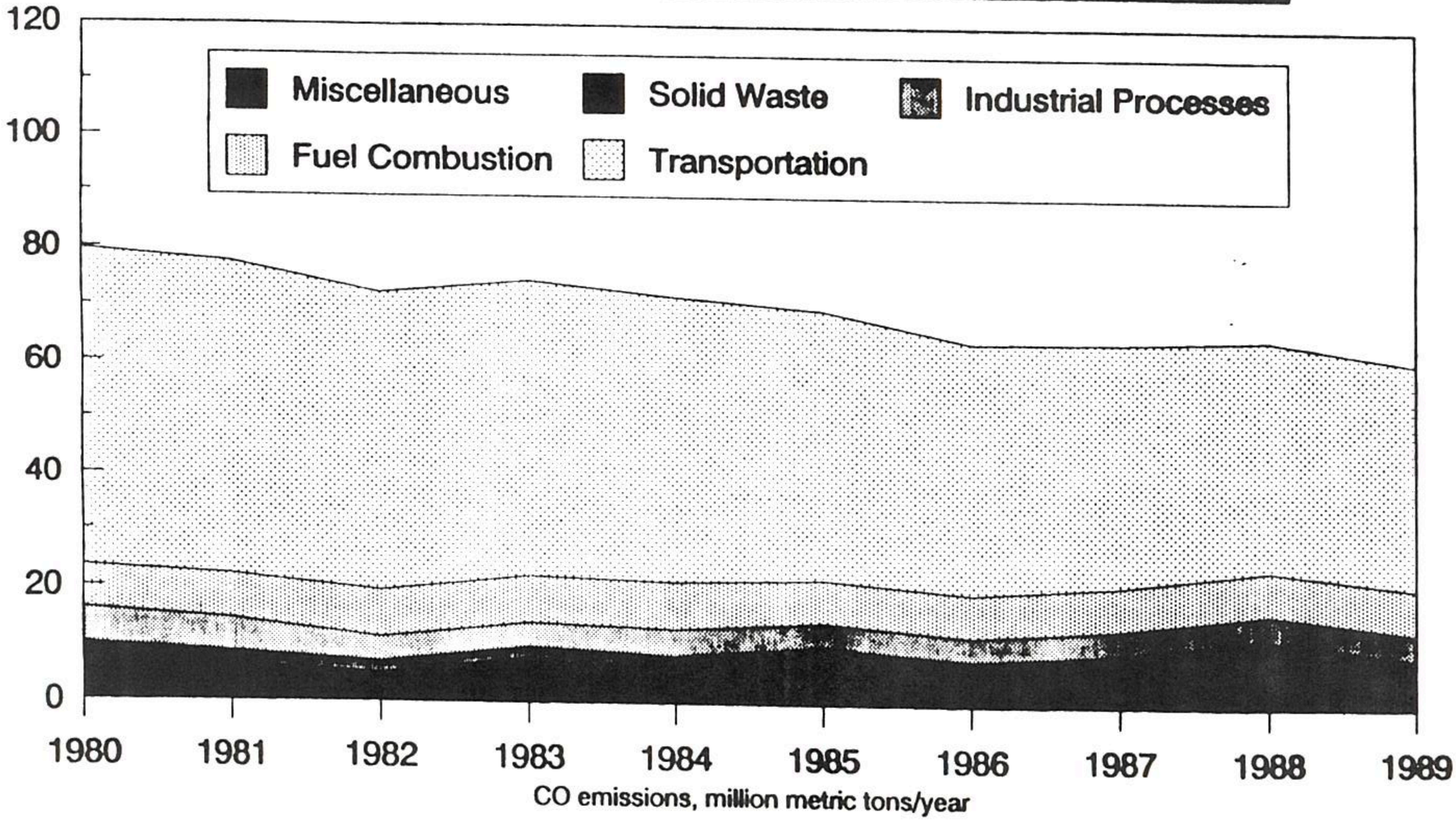


Figure 7
Mid-Atlantic Scenario

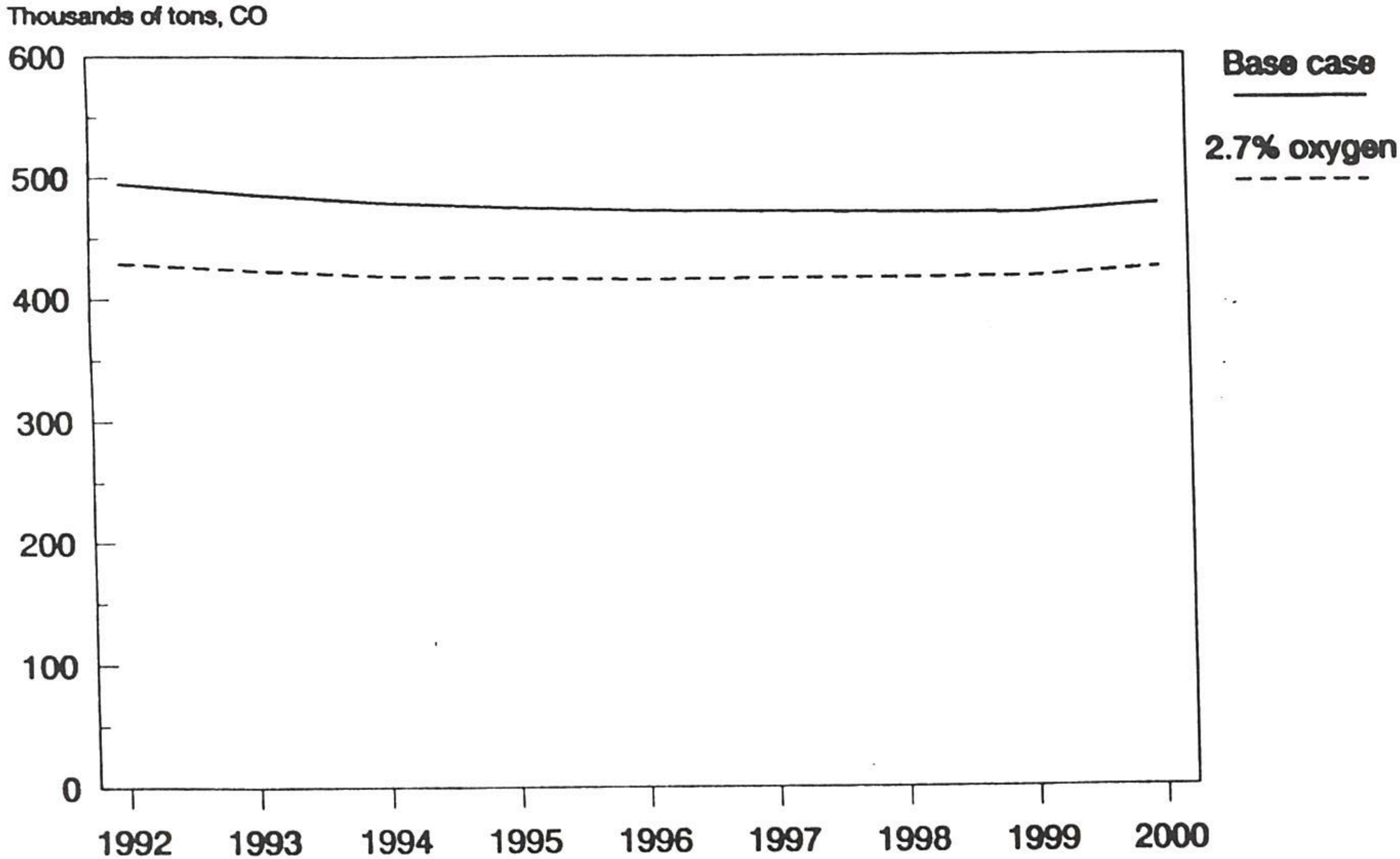
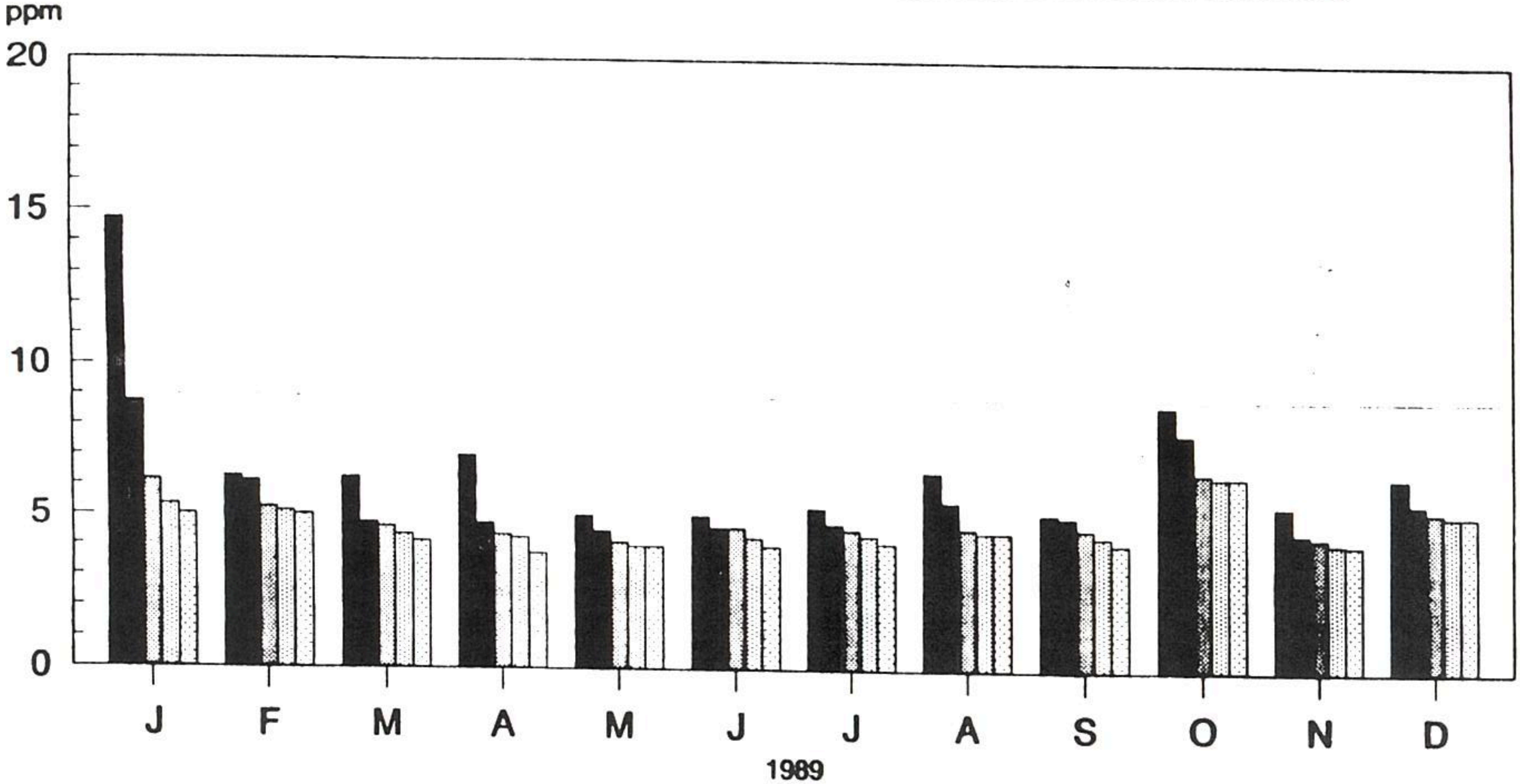
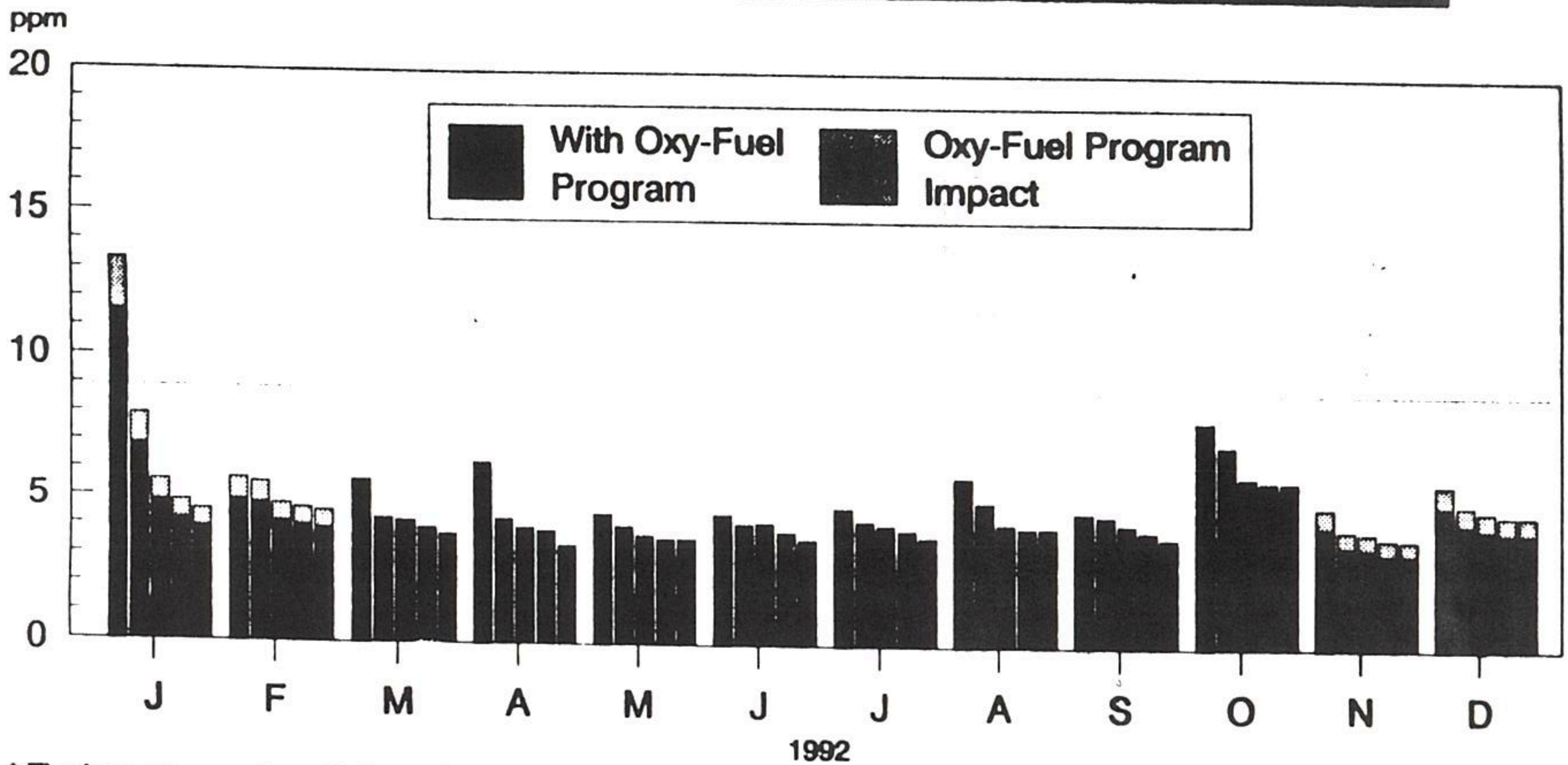


Figure 8
*Top Five Monthly 8-Hour CO Concentrations**
Philadelphia Metropolitan -- 1989



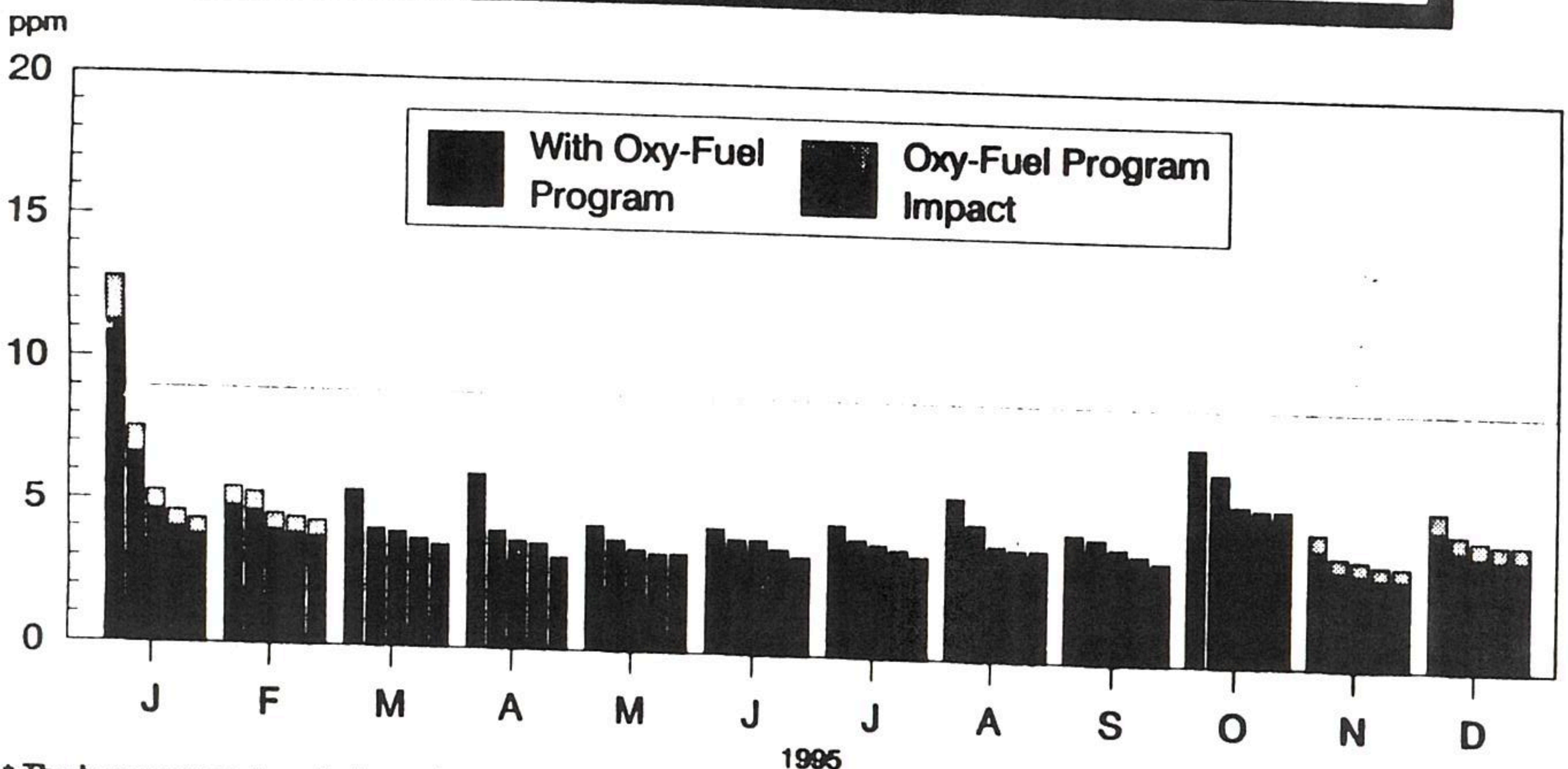
* The bars represent the five highest daily
8-hour CO readings within each month.

Figure 9
Predicted CO Concentrations with Oxy-Fuels Effect
Philadelphia Metropolitan -- 1992



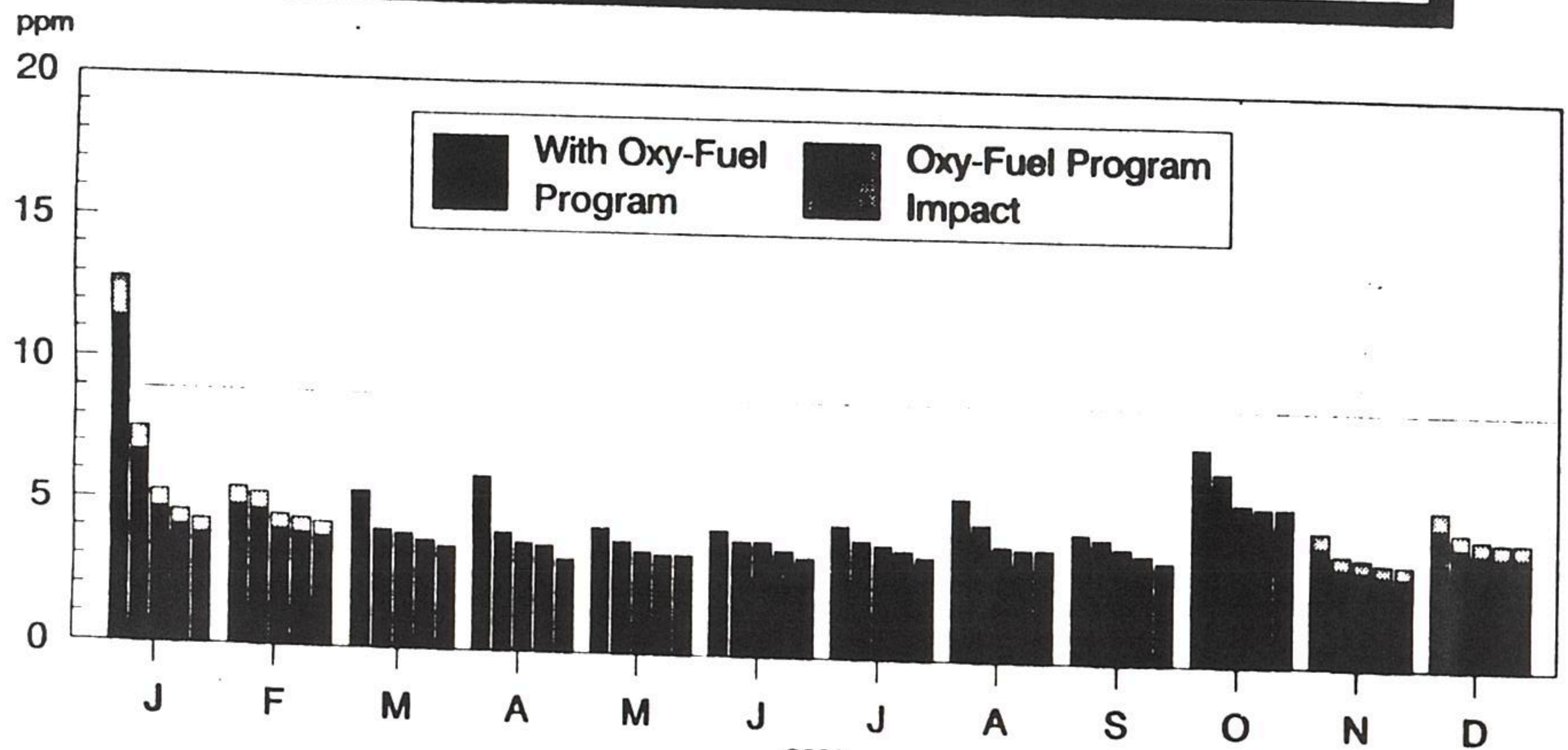
* The bars represent predictions of the five highest daily 8-hour CO readings within each month.

Figure 10
Predicted CO Concentrations with Oxy-Fuels Effect
Philadelphia Metropolitan -- 1995



* The bars represent predictions of the five highest daily 8-hour CO readings within each month.

Figure 11
Predicted CO Concentrations with Oxy-Fuels Effect
Philadelphia Metropolitan -- 2000



* The bars represent predictions of the five highest daily 8-hour CO readings within each month.

Table 2

Cost-Effectiveness of CO Oxygenate Program
Mid-Atlantic City -- 4-Month Period

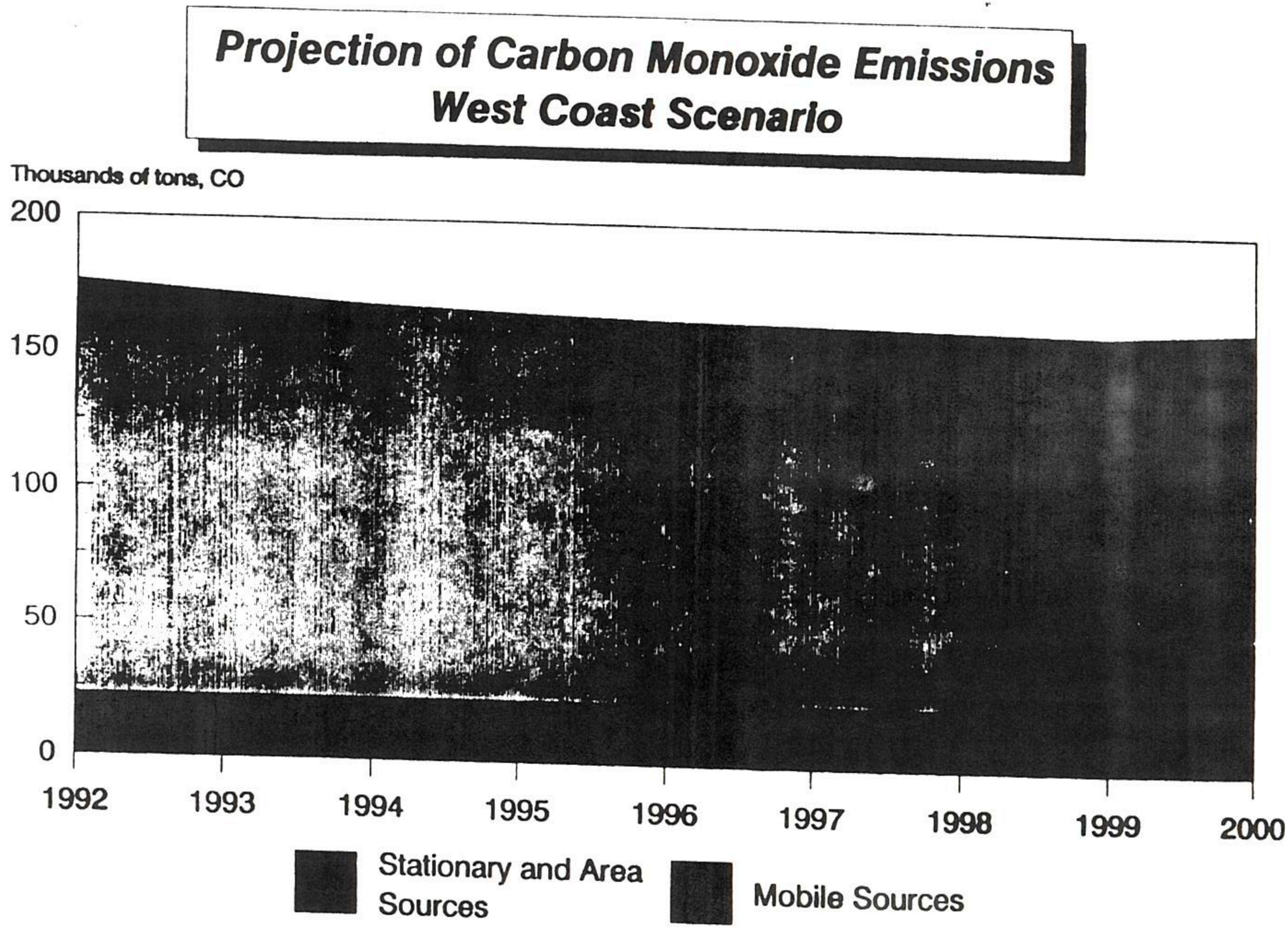
Cal. Year	Gasoline (mil. gal.) (4-Mo.)	Program Cost per gal.	Total Cost (millions)	Program Benefit (tons)	Program Cost/Ton
1992	714.9	$0.0205	$14.7	66,061	$222
1993	729.5	$0.0205	$15.0	63,162	$237
1994	745.9	$0.0205	$15.3	61,101	$250
1995	764.2	$0.0205	$15.7	58,874	$266
1996	783.0	$0.0205	$16.1	56,890	$282
1997	803.3	$0.0205	$16.5	55,402	$297
1998	825.4	$0.0205	$16.9	54,278	$312
1999	848.7	$0.0205	$17.4	52,779	$330
2000	873.3	$0.0205	$17.9	53,220	$336

Table 3

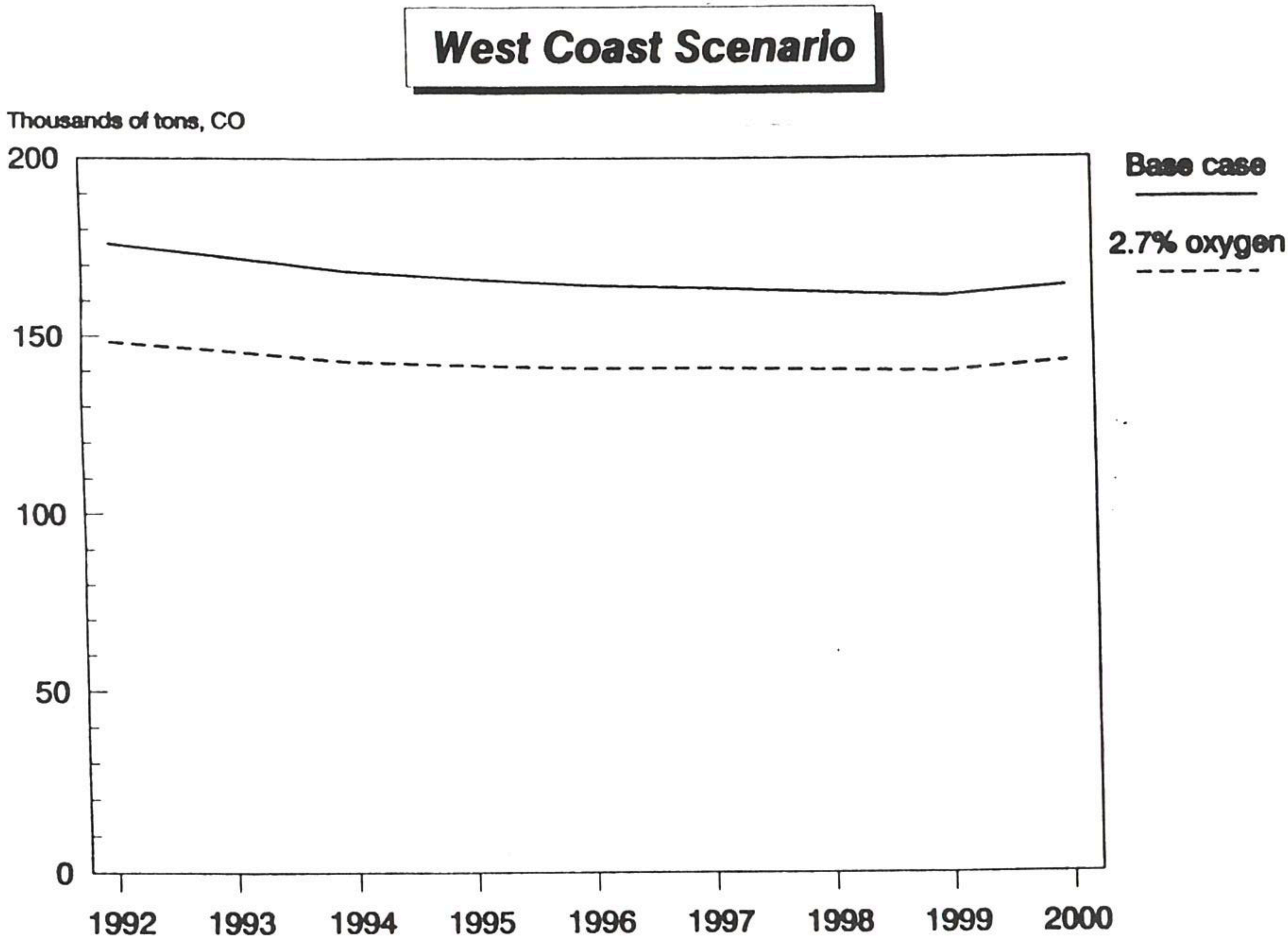
Cost-Effectiveness of CO Oxygenate Program
West Coast City -- 4 Month Control Period

Cal. Year	Gasoline (mil. gal.) (4-Mo.)	Program Cost per gal.	Total Cost (millions)	Program Benefit (tons)	Program Cost/Ton
1992	314.8	$0.0435	$13.7	27,888	$491
1993	321.2	$0.0435	$14.0	26,599	$525
1994	328.5	$0.0435	$14.3	25,541	$559
1995	336.5	$0.0435	$14.6	24,482	$598
1996	344.8	$0.0435	$15.0	23,534	$637
1997	353.8	$0.0435	$15.4	22,829	$674
1998	363.5	$0.0435	$15.8	22,090	$716
1999	373.7	$0.0435	$16.3	21,418	$759
2000	384.6	$0.0435	$16.7	21,506	$778

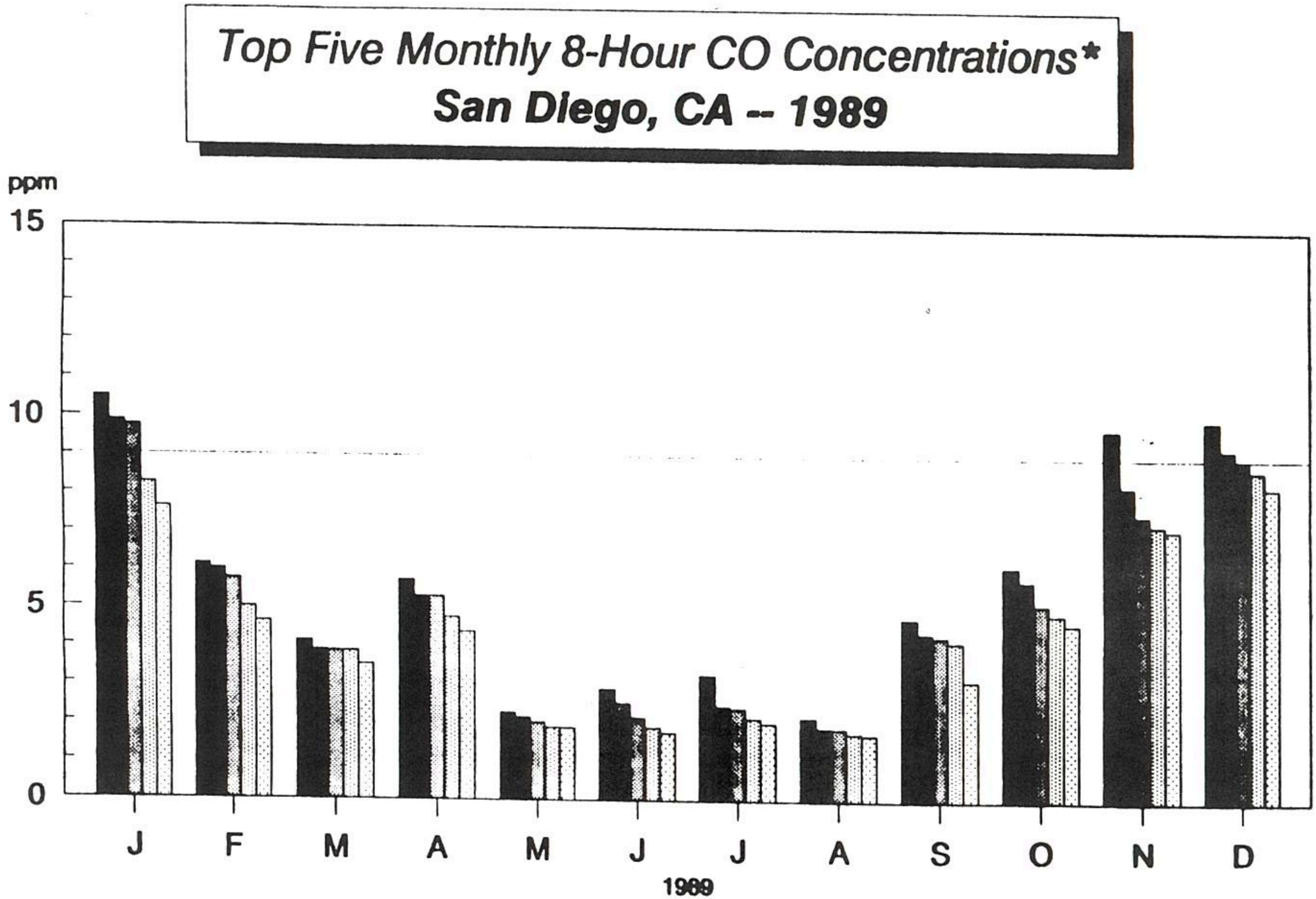
Appendix A



Projection of Carbon Monoxide Emissions
West Coast Scenario
Thousands of tons, CO
200
150
100
50
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
Stationary and Area Sources
Mobile Sources

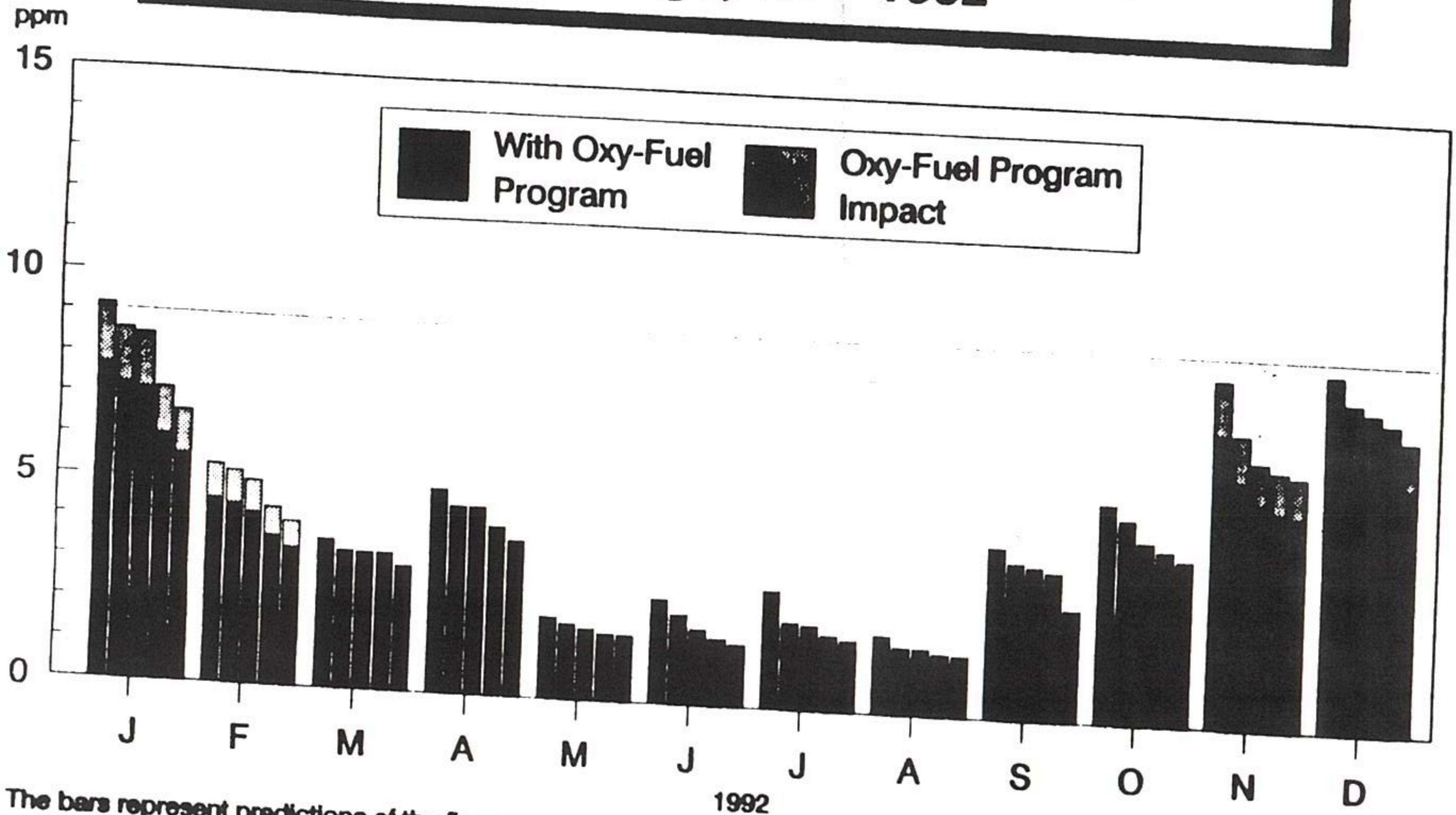


West Coast Scenario
Thousands of tons, CO
200
150
100
50
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
Base case
2.7% oxygen

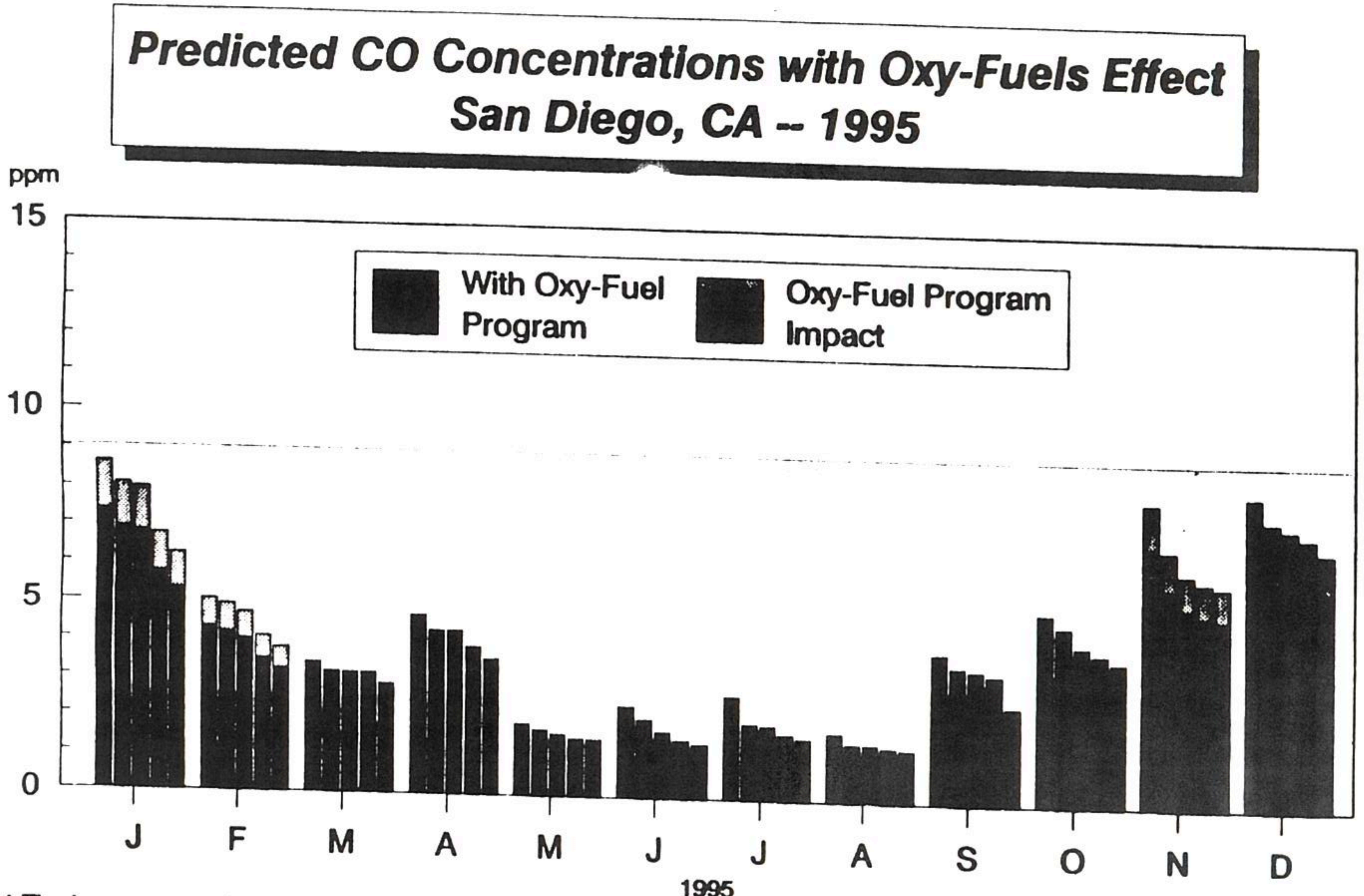


* The bars represent the five highest daily 8-hour CO readings within each month.

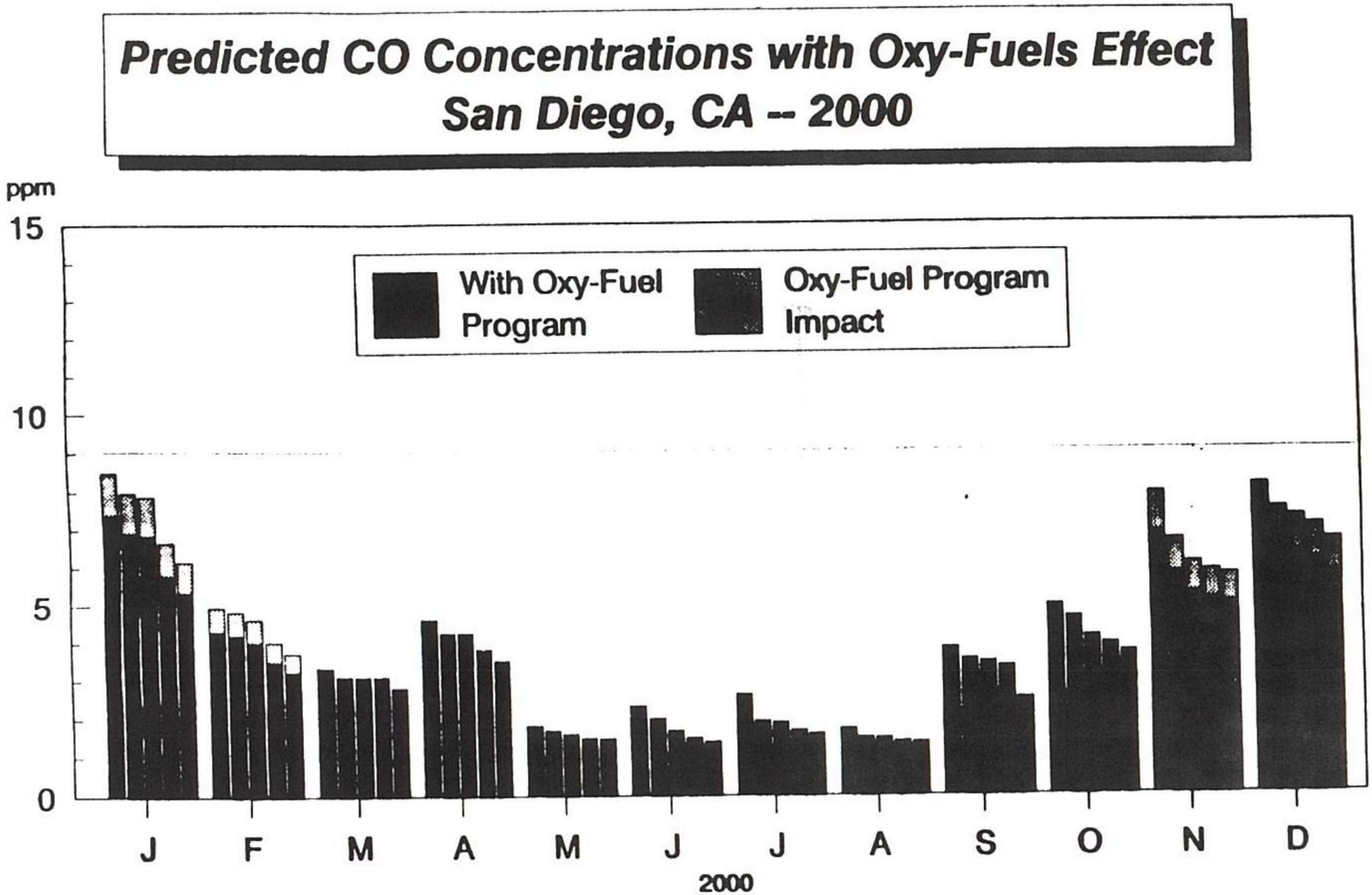
Predicted CO Concentrations with Oxy-Fuels Effect
San Diego, CA -- 1992



* The bars represent predictions of the five highest daily 8-hour CO readings within each month.



* The bars represent predictions of the five highest daily 8-hour CO readings within each month.



* The bars represent predictions of the five highest daily 8-hour CO readings within each month.

Appendix B

Philadelphia Scenario

Year	BASE Vehicle Class	BASE Emission Factor (grams per mile)	BASE VMT (billion miles per 4 months)	BASE Total CO (billion grams)	2.7% OXY Vehicle Class	2.7% OXY Emission Factor (grams per mile)	2.7% OXY VMT (billion miles per 4 months)	2.7% OXY Total CO (billion grams)	Mobile Source (% Reduction)	Mobile + Stationary (% Reduction)
1992	LDGV	21.08	9.31	196.20	LDGV	17.24	9.31	160.46		
	LDGT	25.53	3.83	97.80	LDGT	20.54	3.83	78.68		
	HDGV	55.86	0.51	28.32	HDGV	45.86	0.51	23.25		
	LDDV	1.48	0.07	0.11	LDDV	1.48	0.07	0.11		
	LDDT	1.57	0.04	0.07	LDDT	1.57	0.04	0.07		
	HDDV	11.72	1.10	12.91	HDDV	11.72	1.10	12.91		
	TOTAL			335.40	TOTAL			275.47	17.87%	13.32%
1993	LDGV	19.96	9.56	190.83	LDGV	16.40	9.56	156.79		
	LDGT	24.14	4.01	96.69	LDGT	19.53	4.01	78.22		
	HDGV	50.89	0.52	26.66	HDGV	41.72	0.52	21.86		
	LDDV	1.45	0.07	0.09	LDDV	1.45	0.07	0.09		
	LDDT	1.55	0.04	0.06	LDDT	1.55	0.04	0.06		
	HDDV	11.51	1.16	13.29	HDDV	11.51	1.16	13.29		
	TOTAL			327.62	TOTAL			270.32	17.49%	12.98%
1994	LDGV	18.96	9.82	186.24	LDGV	15.63	9.82	153.53		
	LDGT	23.11	4.18	96.59	LDGT	18.77	4.18	78.45		
	HDGV	46.64	0.54	25.27	HDGV	38.18	0.54	20.69		
	LDDV	1.42	0.06	0.08	LDDV	1.42	0.06	0.08		
	LDDT	1.53	0.03	0.05	LDDT	1.53	0.03	0.05		
	HDDV	11.34	1.21	13.71	HDDV	11.34	1.21	13.71		
	TOTAL			321.95	TOTAL			266.52	17.22%	12.70%
1995	LDGV	18.09	10.09	182.61	LDGV	14.99	10.09	151.31		
	LDGT	22.17	4.35	96.52	LDGT	18.11	4.35	78.84		
	HDGV	43.37	0.56	24.32	HDGV	35.45	0.56	19.88		
	LDDV	1.40	0.05	0.07	LDDV	1.40	0.05	0.07		
	LDDT	1.52	0.03	0.04	LDDT	1.52	0.03	0.04		
	HDDV	11.22	1.26	14.18	HDDV	11.22	1.26	14.18		
	TOTAL			317.74	TOTAL			264.33	16.81%	12.36%
1996	LDGV	17.34	10.36	179.70	LDGV	14.45	10.36	149.75		
	LDGT	21.45	4.52	97.02	LDGT	17.61	4.52	79.65		
	HDGV	40.29	0.58	23.35	HDGV	32.88	0.58	19.06		
	LDDV	1.38	0.04	0.06	LDDV	1.38	0.04	0.06		
	LDDT	1.52	0.02	0.04	LDDT	1.52	0.02	0.04		
	HDDV	11.11	1.32	14.63	HDDV	11.11	1.32	14.63		
	TOTAL			314.79	TOTAL			263.18	16.40%	12.02%
1997	LDGV	16.72	10.64	177.90	LDGV	14.01	10.64	149.07		
	LDGT	20.89	4.69	98.03	LDGT	17.23	4.69	80.85		
	HDGV	38.42	0.60	23.01	HDGV	31.32	0.60	18.76		
	LDDV	1.38	0.04	0.05	LDDV	1.38	0.04	0.05		
	LDDT	1.53	0.02	0.03	LDDT	1.53	0.02	0.03		
	HDDV	11.03	1.37	15.10	HDDV	11.03	1.37	15.10		
	TOTAL			314.13	TOTAL			263.87	16.00%	11.73%

Philadelphia Scenario

Year	BASE Vehicle Class	BASE Emission Factor (grams per mile)	BASE VMT (billion miles per 4 months)	BASE Total CO (billion grams)	2.7% OXY Vehicle Class	2.7% OXY Emission Factor (grams per mile)	2.7% OXY VMT (billion miles per 4 months)	2.7% OXY Total CO (billion grams)	Mobile Source (% Reduction)	Mobile + Stationary (% Reduction)
1998	LDGV	16.22	10.93	177.21	LDGV	13.64	10.93	149.03		
	LDGT	20.16	4.86	98.03	LDGT	16.67	4.86	81.06		
	HDGV	35.43	0.62	21.95	HDGV	28.84	0.62	17.87		
	LDDV	1.39	0.03	0.04	LDDV	1.39	0.03	0.04		
	LDDT	1.53	0.02	0.02	LDDT	1.53	0.02	0.02		
	HDDV	10.98	1.42	15.61	HDDV	10.98	1.42	15.61		
	TOTAL			312.87	TOTAL			263.63	15.74%	11.52%
1999	LDGV	15.52	11.22	174.12	LDGV	13.13	11.22	147.31		
	LDGT	19.85	5.03	99.90	LDGT	16.48	5.03	82.94		
	HDGV	34.32	0.64	21.99	HDGV	27.91	0.64	17.88		
	LDDV	1.39	0.03	0.03	LDDV	1.39	0.03	0.03		
	LDDT	1.55	0.01	0.02	LDDT	1.55	0.01	0.02		
	HDDV	10.92	1.47	16.10	HDDV	10.92	1.47	16.10		
	TOTAL			312.17	TOTAL			264.29	15.34%	11.22%
2000	LDGV	15.59	11.52	179.61	LDGV	13.21	11.52	152.19		
	LDGT	19.29	5.20	100.39	LDGT	16.08	5.20	83.68		
	HDGV	33.46	0.66	22.18	HDGV	27.19	0.66	18.02		
	LDDV	1.39	0.02	0.03	LDDV	1.39	0.02	0.03		
	LDDT	1.55	0.01	0.02	LDDT	1.55	0.01	0.02		
	HDDV	10.88	1.53	16.61	HDDV	10.88	1.53	16.61		
	TOTAL			318.83	TOTAL			270.55	15.14%	11.14%

San Diego Scenario

		BASE				2.7% OXY				
Year	Vehicle Class	Emission Factor (grams per mile)	VMT (billion miles per 4 months)	Total CO (billion grams)	Vehicle Class	Emission Factor (grams per mile)	VMT (billion miles per 4 months)	Total CO (billion grams)	Mobile Source (% Reduction)	Mobile + Stationary (% Reduction)
1992	LDGV	19.29	4.10	79.06	LDGV	15.72	4.10	64.43		
	LDGT	24.99	1.69	42.16	LDGT	20.00	1.69	33.74		
	HDGV	56.08	0.22	12.52	HDGV	46.01	0.22	10.27		
	LDDV	1.48	0.03	0.05	LDDV	1.48	0.03	0.05		
	LDDT	1.57	0.02	0.03	LDDT	1.57	0.02	0.03		
	HDDV	11.72	0.48	5.68	HDDV	11.72	0.48	5.68		
	TOTAL			139.50	TOTAL			114.20	18.13%	15.81%
1993	LDGV	18.22	4.21	76.71	LDGV	14.92	4.21	62.82		
	LDGT	23.48	1.76	41.41	LDGT	18.90	1.76	33.34		
	HDGV	51.74	0.23	11.94	HDGV	42.38	0.23	9.78		
	LDDV	1.45	0.03	0.04	LDDV	1.45	0.03	0.04		
	LDDT	1.55	0.02	0.03	LDDT	1.55	0.02	0.03		
	HDDV	11.51	0.51	5.85	HDDV	11.51	0.51	5.85		
	TOTAL			135.98	TOTAL			111.85	17.75%	15.42%
1994	LDGV	17.14	4.33	74.14	LDGV	14.08	4.33	60.91		
	LDGT	22.20	1.84	40.86	LDGT	17.94	1.84	33.02		
	HDGV	48.01	0.24	11.46	HDGV	39.27	0.24	9.37		
	LDDV	1.42	0.03	0.04	LDDV	1.42	0.03	0.04		
	LDDT	1.53	0.01	0.02	LDDT	1.53	0.01	0.02		
	HDDV	11.34	0.53	6.04	HDDV	11.34	0.53	6.04		
	TOTAL			132.56	TOTAL			109.39	17.47%	15.13%
1995	LDGV	16.31	4.45	72.50	LDGV	13.48	4.45	59.92		
	LDGT	21.12	1.92	40.49	LDGT	17.16	1.92	32.90		
	HDGV	45.14	0.25	11.15	HDGV	36.87	0.25	9.10		
	LDDV	1.40	0.02	0.03	LDDV	1.40	0.02	0.03		
	LDDT	1.52	0.01	0.02	LDDT	1.52	0.01	0.02		
	HDDV	11.22	0.56	6.24	HDDV	11.22	0.56	6.24		
	TOTAL			130.43	TOTAL			108.22	17.03%	14.72%
1996	LDGV	15.60	4.56	71.19	LDGV	12.97	4.56	59.19		
	LDGT	20.25	1.99	40.33	LDGT	16.56	1.99	32.98		
	HDGV	42.43	0.26	10.83	HDGV	34.61	0.26	8.83		
	LDDV	1.38	0.02	0.03	LDDV	1.38	0.02	0.03		
	LDDT	1.52	0.01	0.02	LDDT	1.52	0.01	0.02		
	HDDV	11.11	0.58	6.44	HDDV	11.11	0.58	6.44		
	TOTAL			128.84	TOTAL			107.49	16.57%	14.29%
1997	LDGV	14.99	4.69	70.24	LDGV	12.53	4.69	58.71		
	LDGT	19.54	2.07	40.38	LDGT	16.06	2.07	33.19		
	HDGV	40.82	0.26	10.77	HDGV	33.26	0.26	8.77		
	LDDV	1.38	0.02	0.02	LDDV	1.38	0.02	0.02		
	LDDT	1.53	0.01	0.01	LDDT	1.53	0.01	0.01		
	HDDV	11.03	0.60	6.65	HDDV	11.03	0.60	6.65		
	TOTAL			128.07	TOTAL			107.36	16.17%	13.94%

San Diego Scenario

Year	BASE Vehicle Class	BASE Emission Factor (grams per mile)	BASE VMT (billion miles per 4 months)	BASE Total CO (billion grams)	2.7% OXY Vehicle Class	2.7% OXY Emission Factor (grams per mile)	2.7% OXY VMT (billion miles per 4 months)	2.7% OXY Total CO (billion grams)	Mobile Source (% Reduction)	Mobile + Stationary (% Reduction)
1998	LDGV	14.48	4.81	69.67	LDGV	12.17	4.81	58.55		
	LDGT	18.66	2.14	39.96	LDGT	15.40	2.14	32.98		
	HDGV	38.30	0.27	10.45	HDGV	31.17	0.27	8.50		
	LDDV	1.39	0.01	0.02	LDDV	1.39	0.01	0.02		
	LDDT	1.53	0.01	0.01	LDDT	1.53	0.01	0.01		
	HDDV	10.98	0.63	6.88	HDDV	10.98	0.63	6.88		
	TOTAL			126.98	TOTAL			106.94	15.78%	13.59%
1999	LDGV	13.76	4.94	67.98	LDGV	11.63	4.94	57.46		
	LDGT	18.23	2.22	40.40	LDGT	15.10	2.22	33.47		
	HDGV	37.32	0.28	10.53	HDGV	30.34	0.28	8.56		
	LDDV	1.39	0.01	0.02	LDDV	1.39	0.01	0.02		
	LDDT	1.55	0.01	0.01	LDDT	1.55	0.01	0.01		
	HDDV	10.92	0.65	7.09	HDDV	10.92	0.65	7.09		
	TOTAL			126.03	TOTAL			106.60	15.42%	13.28%
2000	LDGV	13.77	5.07	69.86	LDGV	11.67	5.07	59.21		
	LDGT	17.76	2.29	40.70	LDGT	14.77	2.29	33.85		
	HDGV	36.56	0.29	10.67	HDGV	29.70	0.29	8.67		
	LDDV	1.39	0.01	0.01	LDDV	1.39	0.01	0.01		
	LDDT	1.55	0.00	0.01	LDDT	1.55	0.00	0.01		
	HDDV	10.88	0.67	7.31	HDDV	10.88	0.67	7.31		
	TOTAL			128.57	TOTAL			109.06	15.17%	13.09%

Assumptions for OXY4 Mobile Source Emissions Model
Mid-Atlantic Scenario, January

I/M program selected:

Start year (January 1):	1984
Pre-1981 MYR stringency rate:	20%
First model year covered:	1968
Last model year covered:	2020
Waiver rate (pre-1981):	5.%
Waiver rate (1981 and newer):	5.%
Compliance Rate:	97.%
Inspection type:	Computerized decentralized
Inspection frequency	Annual
Vehicle types covered:	LDGV - Yes
	LDGT1 - Yes
	LDGT2 - Yes
	HDGV - No
1981 & later MYR test type:	Idle

Anti-tampering program selected:

Start year (January 1):	1984
First model year covered:	1975
Last model year covered:	2020
Vehicle types covered:	LDGV , LDGT1, LDGT2
Type:	Decentralized
Frequency:	Annual
Compliance Rate:	97.0%
Air pump system disablements:	Yes
Catalyst removals:	Yes
Fuel inlet restrictor disablements:	Yes
Tailpipe lead deposit test:	No
EGR disablement:	Yes
Evaporative system disablements:	Yes
PCV system disablements:	Yes
Missing gas caps:	No

Non-methane HC emission factors include evaporative HC emission factors.

Ambient Temp: 42.5 / 42.5 / 42.5 (F)	Region: Low
Operating Mode: 20.6 / 27.3 / 20.6	Altitude: 500. Ft.
ASTM Class: E	Average Speed: 19.6 mph
Minimum Temp: 22. (F)	Maximum Temp: 52. (F)
Base RVP: 15.00	In-use RVP: 15.00
Base Case Fuel Oxygen Content: .1%	Oxy Case Fuel Oxygen Content: 2.7%

Assumptions for OXY4 Mobile Source Emissions Model
West Coast Scenario, January

I/M program selected:

Start year (January 1):	1984
Pre-1981 MYR stringency rate:	20%
First model year covered:	1972
Last model year covered:	2020
Waiver rate (pre-1981):	5.%
Waiver rate (1981 and newer):	5.%
Compliance Rate:	97.%
Inspection type:	Computerized decentralized
Inspection frequency	Biennial
Vehicle types covered:	LDGV - Yes
	LDGT1 - Yes
	LDGT2 - Yes
	HDGV - No
1981 & later MYR test type:	Idle

Anti-tampering program selected:

Start year (January 1):	1984
First model year covered:	1984
Last model year covered:	2020
Vehicle types covered:	LDGV , LDGT1, LDGT2
Type:	Decentralized
Frequency:	Biennial
Compliance Rate:	97.0%
Air pump system disablements:	Yes
Catalyst removals:	Yes
Fuel inlet restrictor disablements:	Yes
Tailpipe lead deposit test:	No
EGR disablement:	Yes
Evaporative system disablements:	Yes
PCV system disablements:	Yes
Missing gas caps:	No

Non-methane HC emission factors include evaporative HC emission factors.

Ambient Temp: 63.7 / 63.7 / 63.7 (F)	Region: Low
Operating Mode: 20.6 / 27.3 / 20.6	Altitude: 500. Ft.
ASTM Class: D	Average Speed: 19.6 mph
Minimum Temp: 36. (F)	Maximum Temp: 76. (F)
Base RVP: 13.50	In-use RVP: 13.50
Base Case Fuel Oxygen Content: .1%	Oxy Case Fuel Oxygen Content: 2.7%